Nomination of

CHARTERS TOWERS WATER SUPPLY

Queensland

for ENGINEERING HERITAGE RECOGNITION

under the ENGINEERING HERITAGE RECOGNITION PROGRAM

Submitted by: ***Engineering Heritage Queensland***

Prepared for EHQ by: ***Panel Member***
N H Traves Hon. FIE Aust
November 2015

BASIC DATA

Item Name - Charters Towers Water Supply.

Location - Extends from Weir on Burdekin River and Pumping Station on right bank of river along route of Rising Main to Treatment Plant, Reservoir and Reticulation System in city of Charters Towers, North Queensland.

State - Queensland.

Local Government Area - Charters Towers Regional Council.

Owner - Charters Towers Regional Council.

Current Use - Water Supply to city.

Design, Supervision and Construction - Various engineers and associates as detailed under "History".

Year preparatory work commenced - 1878.

Period in operation - January 1891 to present.

Physical Description - Weir on Burdekin River 12 km northeast of Charters Towers City. Original steam and subsequent two electric pumping stations right bank of river, rising main to water treatment plant in city and to reservoir on Towers Hill, and reticulation system.

Physical Condition - In working order for continuous use, except for original steam pumps which have been preserved for their historical value, and original electric pumping station.

Modification and Dates - Numerous modifications as detailed under History.

Heritage Listing - Charters Towers Water Supply System - National Trust of Queensland 1991. (Queensland Heritage Register, Page 11).

HISTORY

Gold was discovered in Charters Towers in 1871 and the Charters Towers Goldfield was declared in 1872.

Settlements formed on the creeks which provided essential water for the mills processing the ore. The richest reefs were found at Upper Camp, and this settlement grew to become the town of Charters Towers which was proclaimed in 1877.

Annual production of gold exceeded 100,000 fine ounces in 1885 at an average grade of 1.5 ounces per ton and peaked in 1899 at 319,572 fine ounces. Production fell below 100,000 ounces after 1912 and did not recover, but in the meantime the field had made a major contribution to the social and economic development of North Queensland.

Charters Towers was connected by rail to Townsville in 1882, but still depended for its water supply on local creeks and wells, and water carted from the nearby Burdekin River. The area has an "inland" type of climate, and supply from local creeks was variable and unreliable.

In 1878 the newly-appointed Resident Engineer for Northern Waterworks, John Baillie Henderson, M.Inst.C.E., made a brief examination of the area and prepared a report, sketch map and estimate for supplying the town with water from the obvious potential source, the Burdekin River, but no action was taken on this report because of the cost.

By the 1880's Charters Towers had become a prosperous settlement of national importance but still with no sanitation or reticulated water supply. Because mining towns were often transitory, it was common for the need for infrastructure to be disregarded.

Crushing of ore was slowed down because of the unreliable supply of water from creeks in the dry season, and the people of the town survived on well water that was often contaminated. There were frequent outbreaks of typhoid.

The year 1883 was the first of three very dry years, and water had to be brought to the town by rail. Henderson's scheme was revised and modified to include surrounding areas. Two pumping stations were proposed with each having two compound, direct-acting, condensing, differential steam engines. The term differential here refers to the Davey Differential system of installing non-rotating steam engines. Henderson had meanwhile become State Hydraulic Engineer and pointed out that the town was inadequately supplied with water, but the government would not contribute towards the cost of the scheme. However, after a speculative boom in the town in 1886, Henderson was instructed to prepare a proposal for a cheaper scheme. This he did by proposing reducing the number of pumping engines to one, with

the single steam engine pumping through a 12 inch dia. rising main to a reservoir on Towers Hill, and gravity reticulation system.

This revised scheme was reported in detail in "The Queenslander" on 30 July 1887, and was duly approved. Provision was made for duplicating the pumping engines when this became necessary.

Equipment was ordered and Frederick Talbot Joyce AM Inst.C.E. was appointed engineer to the Charters Towers Waterworks Board.

There were problems during construction. The reservoir had to be relined with cement concrete on its brick walls, there were leakage problems with the cast iron pipe joints and the boilers that powered the pumping engine had to be modified to operate on wood instead of the intended coal fuel.

Joyce resigned in 1890 and handed over to his assistant, William Bolland.

Water was turned on in 1891. Meanwhile, an aerial tramway was built across the river to access more economical sources of firewood, and an identical pumping engine was started in 1896.

Demand for water increased because of the increase in population and greater use by the mines. Because of a drought in 1900-02, river flow ceased and trenches had to be dug to get water to the pumping station. Bolland was instructed to build a weir to hold water. Construction was commenced in July 1902 and completed by December. The weir of capacity 400m gallons, was exceptional in scale for its time. It was 900 feet long with a maximum height of 16 feet, and became a recreational area for the city.

Operation of the pumping system was labour-intensive, and covered the provision of firewood from areas on the far (left bank) side of the river, transport of the firewood to and across the river by tramway and aerial tram ("flying fox"), fuelling of the steam boilers and operation of the pumping engines.

Cottages and a school were provided at the site to cater for the families of workers.

In 1941 the Charters Towers Electric Supply Company, which provided power for the city and surrounds, proposed that the steam pumping equipment be replaced by electric centrifugal pumps, with a substantial saving in costs. The proposal was adopted in 1942 and was implemented by 1944.

The new system with electric pumps meant that labour requirements were reduced substantially, and some of the staff cottages were sold and removed.

The system was reviewed by Gutteridge Haskins & Davey, Consulting Engineers, in 1954. A contract was let for new electrical pumping equipment and automatic control equipment was installed, further reducing staff numbers required to operate the system.

The consulting engineers had investigated the possibility of reducing electric power costs from the local generating station. The report indicated that operation of the centrifugal pumps by direct-coupled diesel engines could be economically sound. At this stage however, power became available through a high-tension transmission line from Townsville, with a consequent reduction in unit costs of power, so the change was not warranted.

The capacity of the rising main to the town reservoir was substantially increased in 1961.

This was done by replacing half the length of the 12 inch cast iron main, from the pumping station towards the city, by a 15 inch diameter welded steel main, and re-laying the recovered 12 inch pipes in parallel with the existing 12 inch main from the halfway point to the reservoir.

This provided a capacity of 2¼m gallons per day, and water restrictions were lifted in May 1961.

A water treatment plant was constructed and commenced operation in 1974. It provides the usual processes of coagulation, sedimentation, filtration and disinfection by chlorination.

A new pumping station, similarly with centrifuge low lift and high lift pumps, was built on Reserve 122 adjacent to the weir in 1975, and named after Phil Matthews who had been manager of the pumping operations for 32 years.

Those works brought the system into compliance with accepted modern standards for a city water supply system.

A group of specialist enthusiasts from the International Stationary Steam Engine Society (ISSES) became interested in the original steam pumping station in 1989, and has been successful in preserving these engines, which have been listed in the Queensland Heritage Register.

ASSESSMENT OF SIGNIFICANCE

The Charters Towers Water Supply is of significance for several reasons:

- Historical and commercial significance
- The work of notable individuals associated with the project.

- Developments in engineering technology over a period of more than 100 years.
- Social and civic significance.

HISTORICAL AND COMMERCIAL SIGNIFICANCE

The Charters Towers Water Supply system is of historical significance as it represents a substantial system that was first operated over 100 years ago to supply a city expanding rapidly because of gold mining on a major scale. It was the major example of a pumped water supply system in Queensland, outside and remote from the capital city.

The system made a major contribution to the growth of the gold mining industry in Charters Towers, during a critical period in the economic development of North Queensland and the State of Queensland.

The reliable supply of water significantly contributed to public health and hygiene in a rapidly-growing settlement, and permitted the establishment of public and private gardens to mitigate the austerity of a young mining town.

HISTORIC INDIVIDUALS

The system was initially proposed by John Baillie Henderson, M.Inst.C.E. who at the time was Resident Engineer for Northern Waterworks. The name Henderson subsequently became synonymous with the development and design of water supply systems in Queensland, to the extent that he was commonly referred to as "Hydraulic Henderson".

Henderson described the essentials of the originally proposed system and subsequently, when the cost of the system had to be reduced, made the necessary modifications that enabled the system to be approved and construction to be commenced. Henderson worked in collaboration with his colleague, Frederick Talbot Joyce, a London trained civil engineer, who was appointed site engineer and who also designed the town reticulation system.

The weir on the Burdekin River was designed and its construction supervised by William Bolland who had been site engineer since 1890 and remained Resident Engineer of the water supply section for many years. His son, Elliot Bolland, also worked on the site, and was the Resident Engineer when his father went overseas in 1909. Elliot Bolland resigned as Resident Engineer in 1914, and the position was taken over by Phil Matthews, who was in charge of the project for over 30 years, and for whom the new electric pumping station was named.

ENGINEERING TECHNOLOGY

The magnitude and complexity of this system were at the time of construction notable as features of a major project. The scheme was based on two steam pumping engines consisting of two lift and two force pumps per engine with a cistern between stages. These were inverted cross compound non-rotating engines, manufactured by Hathorn Davey & Co of Leeds, England. They are among the last of the inverted compound configuration known to exist in the world (Peake 1992). The engines were installed in 1890 and operated until 1942, when they were replaced by electric centrifugal pumps. One steam pumping engine continued to work intermittently until 1954.

The pumping engines remain on site and are still in almost working condition. They have been listed by the Queensland National Trust for their heritage value. A committee of interested specialists is endeavouring to return the engines to active operation.

Two Cornish boilers were installed by the end of 1889, at which time the chimney stack was completed to a height of 46 feet, while the flue from the boilers to the stack was under construction.

An engine was successfully tested in June 1890, and the town reservoir was pumped full for the first time in January 1892.

The boilers were wood-fired with fuel being obtained from the far (left) bank of the river where suitable timber was more readily available. Firewood was collected and carried to the river on a small tramway which then crossed the river by a low-level bridge, which had been preferred to an aerial tramway.

A second 20000 gallon per hour pumping engine was installed under the supervision of William Bolland in 1896, and all the machinery commenced operation. The two Cornish boilers proved to be insufficient to maintain steam pressures and comply with operational requirements in 1909. A new Babcock & Wilcox water tube boiler was installed and was operational from June 1910. There were initial difficulties in operating the new boiler in conjunction with the Cornish boilers but these were overcome by reducing the operating pressure of the new water tube boiler to enable it to operate with one of the original Cornish boilers.

Use of the new boiler resulted in a significant saving in the use of firewood, but the cost of firewood remained a major issue.

A tramway was used to carry firewood from the collection area to the river bank and across the river by a low-level timber trestle bridge. The bridge was subject to damage by floods in the river and after an accident in 1907 a decision was made to replace the bridge with an aerial tramway ("flying fox") operated by a steam winch. This tramway was completed in 1914. This

allowed the locomotive to carry in 11 trucks of firewood where previously it could bring only 4 trucks. A large tension wheel was fitted to the tramway in 1916.

A substantial labour force was required to operate the whole operation adjacent to the Burdekin River, covering the collection, cartage and transport of firewood and operation of the boilers and the pumping engines.

Cottages were erected for staff resident at the site, commencing with the residence for the resident engineer in 1888. By 1897 it became necessary for a school to be erected to serve the families of site workers and a cottage for the teacher was erected and was furnished by parents.

The requirement for staff on site was reduced very markedly when the decision was made in 1941 and implemented in 1942 to convert to electric centrifugal low lift and high lift pumps.

Significant problems were encountered with the 12 inch dia. cast iron rising main early as 1892, particularly in the section of the main closest to the pumping station where the combination of static and friction heads was highest. There were nine bursts on the rising main in 1893 and a considerable number of joints had required recaulking.

The rising main was just short of 9 miles in length and covered a static head of 570 feet.

The main crossed a number of creeks and gullies by means of timber trestle bridges, which led to significant maintenance costs and have in most cases been replaced by pipelines buried in the beds of streams.

Cast iron pipe was the standard medium for mains of this diameter at the time, and lead-caulked joints were the standard system for connection of pipes.

The solution when the capacity of the rising main had to be increased in 1958 was to replace half the length of the main, from the pumping station where the operating pressure was the highest, with 15 inch diameter welded steel pipes which by then were readily available, and to reclaim and re-lay the 12 inch cast iron pipes as a parallel main along the lower-pressure section of the main to the town reservoir. After minor failures of welded seams along the steel pipes and welded joints, during pressure testing, the reduction in maintenance costs became apparent.

The service reservoir on Towers Hill was constructed of brick and concrete in 1889 after cement had been imported from England. The reservoir included a lining of concrete. It is 160 feet in diameter, 15 feet high, with a wall 10 feet high across the centre to provide twin storages totalling 1.18 million gallons. Walls and floor were lined with "cement", presumably meaning a plaster of cement-sand mortar.

There were disagreements concerning the quality of work in the walls and floor, specifically in relation to the rendering and the main floor and the remedial work that was carried out.

In 1975 the reservoir was repaired with epoxy, roofed and re-used and a new reservoir was constructed alongside.

Practices with work of this kind have improved over the years since 1889, and similar problems would not be expected with the reinforced concrete walls and floor normally used today, with appropriate compaction of the placed concrete by vibration.

Improvements in technology over the history of the scheme are thus apparent in respect of the pumping equipment, the rising main and the service reservoir although in the main, the original aspects of the scheme worked well for many years before being overtaken by more recent development.

The system as it has been developed since the late 18^{th} century thus illustrates the advances that have been made in technology in the various fields which include

- the pumping equipment and its power supply
- the operational control equipment
- the rising main to the service reservoir
- the reservoir itself.

Consequent on those technological improvements has been the reduction in the number of people involved in the process and a corresponding reduction in the costs of operation.

SOCIAL AND CIVIC SIGNIFICANCE

The water supply system made a major contribution to helping secure a sound level of community hygiene in the town.

Before reticulated water was available, people were either reliant on rain water, or during dry periods on well water which often became contaminated by seepage from the town cesspits. Epidemics were thus common during the dry season, with typhoid reaching levels of thirty per thousand of population in 1883.

Water pumped from the Burdekin River was generally of reasonable quality, partly because of natural filtration through the river sands, and also because

of the generally low level of development and pollution from the catchment area.

Provision of a water treatment plant in 1974 was desirable because of higher levels of population and development in the catchment and more demanding expectations concerning water quality.

The area has generally a hot "inland" type of climate, in which conditions a ready source of potable water is of particular importance.

The reliable supply of water also made a major contribution to the establishment of public and private gardens to mitigate the austerity of a young mining town.

The weir on the Burdekin River also provided a new and reliable recreational facility for residents of the area with opportunities that were not generally available elsewhere in the area.

CONCLUSION

For these various reasons, the water supply system of Charters Towers is worthy of recognition as a notable example of engineering heritage.

REFERENCES

- Queensland Archives files re Charters Towers Water Board and its successors, Charters Towers City Council and Charters Towers Regional Board.
  Most of the information quoted, particularly relating to the early history of the scheme.

- Queensland State Heritage Register, 2014.
  Listing of the (former) Burdekin River Pumping Station details the early history of the steam pumping station and other elements of the system as constructed from 1887 to 1891. The location pf the pumping station is given as Lot 104, DV323. The Register also details the history of the various elements of the system through to the last use of one of the steam pumps in 1954.

- Submission to the Council by Owen Peake on behalf of the International Stationary Steam Engine Society (ISSES) in 1991.
  This submission covers investigations of the original steam pumping engines and proposals for their preservation for their historical value, and other parts of the water supply system.

- A Conservation Study by Michael Gunn Architects and Dr Peter Miller, 1998, for the Charters Towers and Dalrymple Tourism Development Association.
  This document refers to the original steam pumping station and its associated features including boilers and chimney stack. The purpose of the study was to assess the rarity of the machinery of the pumping station and its condition and to develop policy for conservation management of the complex.
  This document details the history of the original pumping station and the system in general.

- Information from Glenys Bolland, the great grand-daughter of William Bolland, the engineer who designed and supervised the construction of the Burdekin River Weir, and who was followed in this position of engineer for the water supply by his son Elliot Bolland.

- Personal recollections of the author, who was associated with work carried out on the system during the 1950's.

LAYOUT PLANS

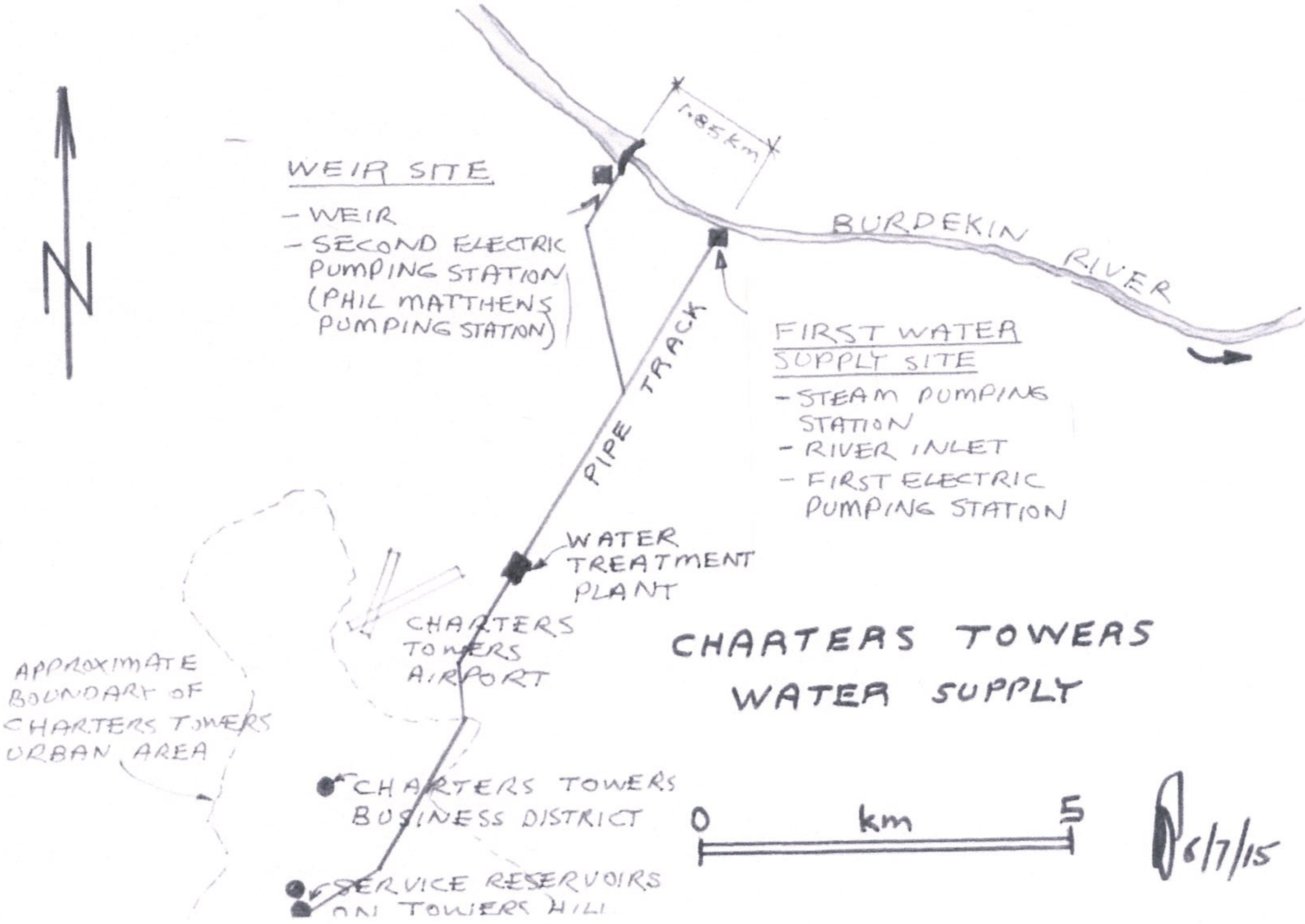
Layout Plans are included:

Locality Sketch (Owen Peake) - The sketch map shows the overall layout of the present system, from the Burdekin River to the Service Reservoir.

Treatment Plant (Charters Towers Regional Council) - This shows the processes involved in the treatment plant and its relationship to the other parts of the scheme.

PHOTOGRAPHS

Photographs show the more significant elements of the system. Names of the persons or organisations involved are shown on the photographs.

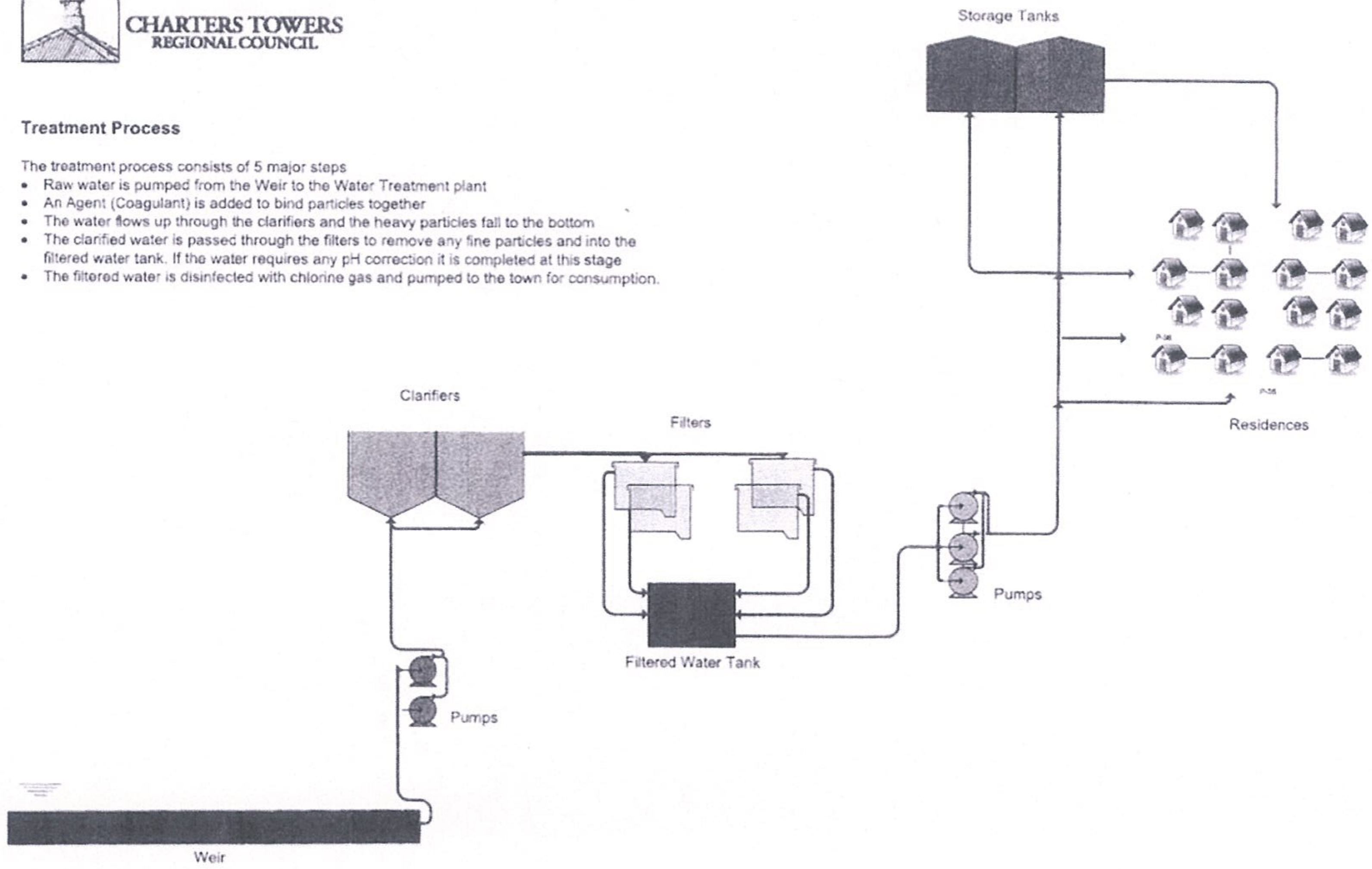

WEIR SITE
- WEIR
- SECOND ELECTRIC PUMPING STATION (PHIL MATTHENS PUMPING STATION)
1.85 km
BURDEKIN RIVER
FIRST WATER SUPPLY SITE
- STEAM PUMPING STATION
- RIVER INLET
- FIRST ELECTRIC PUMPING STATION
PIPE TRACK
WATER TREATMENT PLANT
CHARTERS TOWERS AIRPORT
APPROXIMATE BOUNDARY OF CHARTERS TOWERS URBAN AREA
CHARTERS TOWERS BUSINESS DISTRICT
SERVICE RESERVOIRS ON TOWERS HILL
CHARTERS TOWERS WATER SUPPLY
0
km
5
N
6/7/15

CHARTERS TOWERS
REGIONAL COUNCIL

Treatment Process

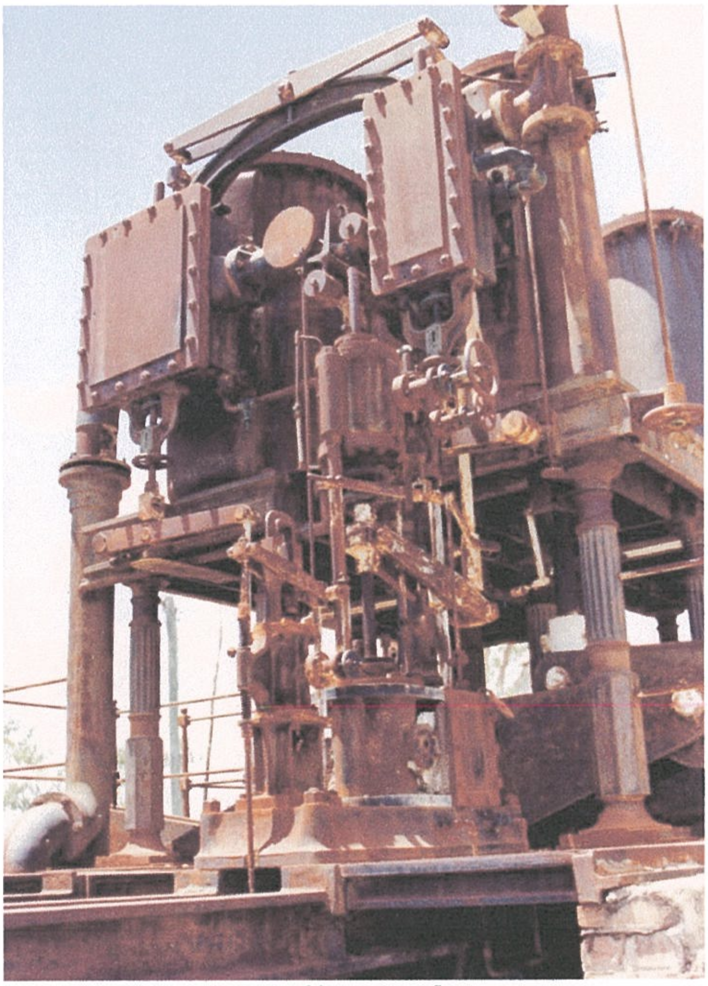
The treatment process consists of 5 major steps

- Raw water is pumped from the Weir to the Water Treatment plant
- An Agent (Coagulant) is added to bind particles together
- The water flows up through the clarifiers and the heavy particles fall to the bottom
- The clarified water is passed through the filters to remove any fine particles and into the filtered water tank. If the water requires any pH correction it is completed at this stage
- The filtered water is disinfected with chlorine gas and pumped to the town for consumption.



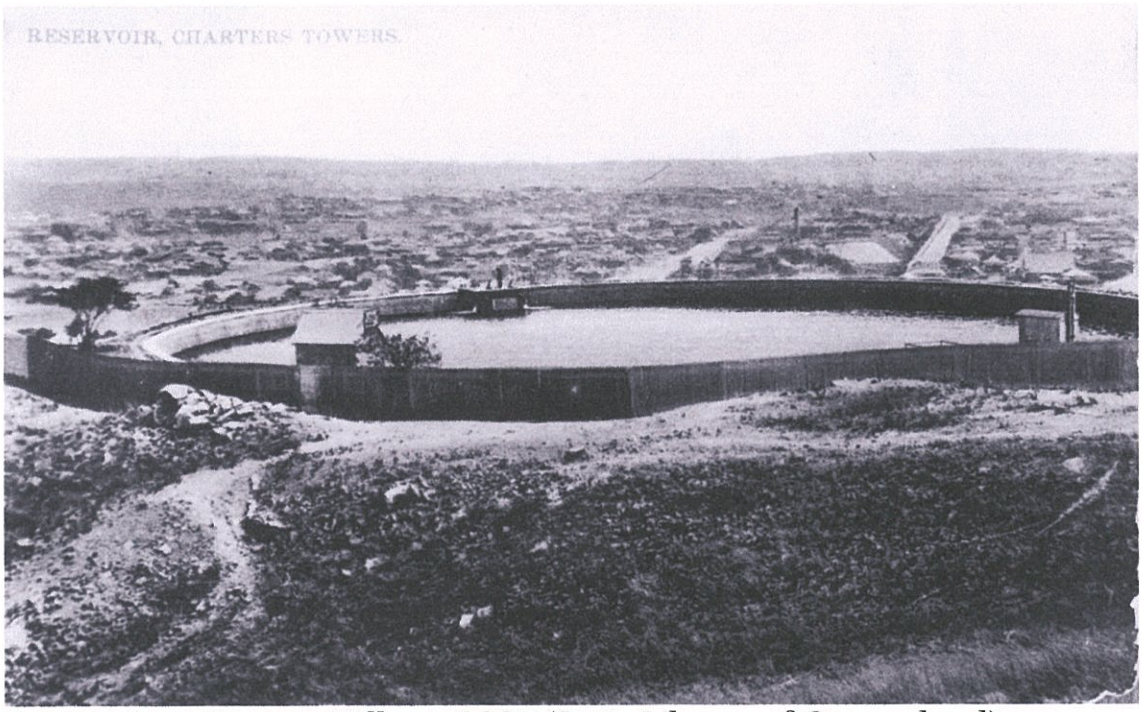
Water Board members including The Governor The Hon. R. Philip inspecting the weir, 1 June 1903 (State Library of Queensland)

Water Board visit to Burdekin Weir, 1 June 1903 (State Library of Queensland)

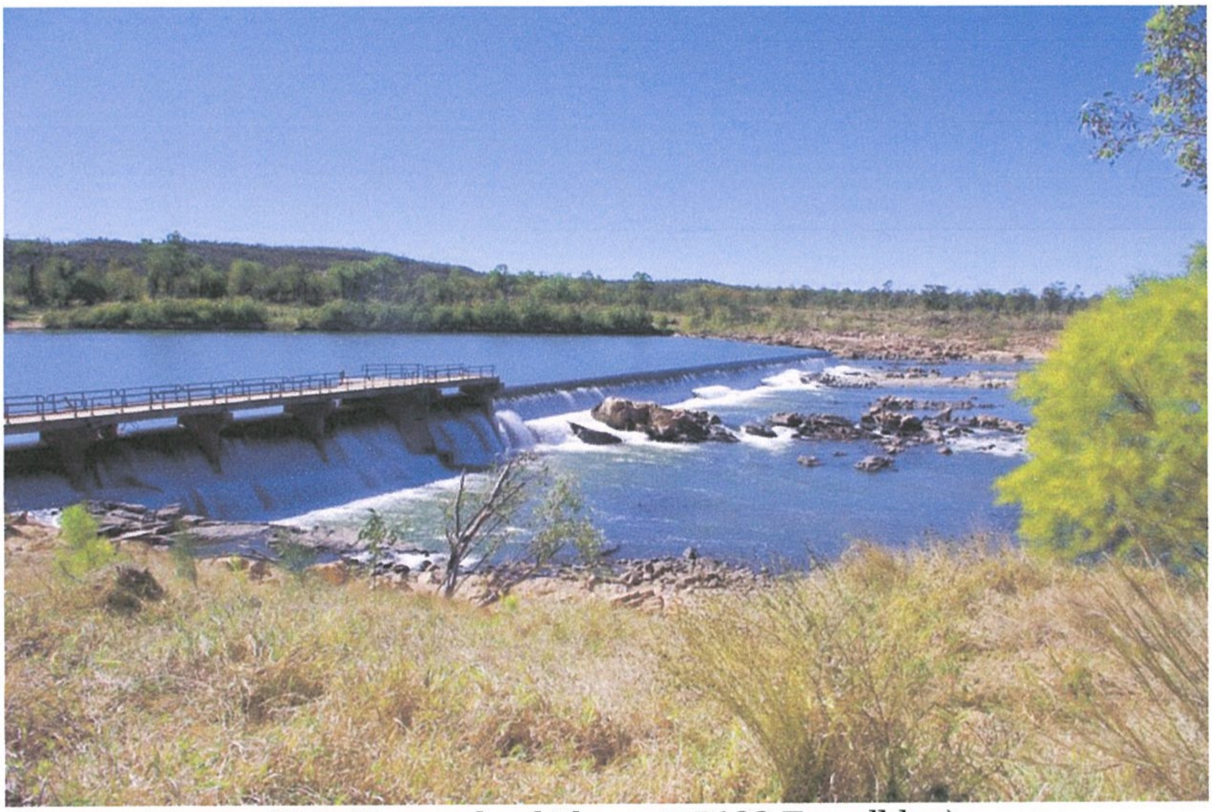

Charters Towers differential pumping engines (Terry Patton 1992)


Charters Towers differential pumping engines (Terry Patton 1992)


New pump house behind original pumping engines (Terry Patton 1992)



Reservoir on Towers Hill, ca. 1907 (State Library of Queensland)



Charters Towers Weir (Queensland Places FLB122 Travelblog)

Charters Towers Weir (Queensland Government)